International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN (P): 2249-6890; ISSN (E): 2249-8001
Vol. 9, Issue 4, Aug 2019, 93-98

SOLVING FUZZY TRANSPORTATION PROBLEM USING RANKING FUNCTION

K. BALASUBRAMANIAN[1] & Dr. S. SUBRAMANIAN[2]

[1]*Research Scholar, Department of Mathematics, Prist University, Thanjavur, Tamil Nadu, India*

[2]*Professor, Department of Mathematics, Prist University, Thanjavur, Tamil Nadu, India*

ABSTRACT

In this paper, a method is proposed to find a solution of transportation problem in fuzzy environment with all parameters are fuzzy inequalities. To illustrate a proposed method a fuzzy transportation problem is solved and results are obtained. This method is easy to understand and apply for finding the optimal solution in fuzzy transportation models in real life problems.

***KEYWORDS**: Transportation Problem, Fuzzy Transportation Problem, Ranking Function, Triangular Fuzzy Number & Fuzzy Sets*

Received: Apr 24, 2019; **Accepted**: May 15, 2019; **Published**: Jun 17, 2019; **Paper Id.**: IJMPERDAUG201910

Original Article

1. INTRODUCTION

Transportation models have wide applications in logistics and supply chain for reducing the cost. When the cost coefficients and the supply and demand quantities are known exactly, many algorithms have been developed for solving the transportation problem. But, in the real world, there are many cases that the cost coefficients and the supply and demand quantities are fuzzy quantities. A fuzzy transportation problem is a transportation problem in which the transportation costs, supply and demand quantities are fuzzy quantities.

Most of the existing techniques provide only crisp solutions for the fuzzy transportation problem. Shiang-Tai Liu *et al.* (2006), Chanas *et al.* (1984), Chanas *et al.* (1996), proposed a method for solving fuzzy transportation problems. Nagoor Gani *et al.* (2004), obtained a fuzzy solution for a two stage cost minimizing fuzzy transportation problem in which supplies and demands are trapezoidal fuzzy numbers. Pandian *et al.* (2010), proposed a method namely, fuzzy zero point methods, for finding a fuzzy optimal solution for a fuzzy transportation problem where all parameters are trapezoidal fuzzy numbers.

We propose a method for ranking and comparing fuzzy numbers to account for the above-mentioned factors as much as possible. First, we transform the fuzzy quantities as the cost, coefficients, supply and demands, in to crisp quantities by using our method obtain the optimal solution of the problem without finding the initial basic feasible solution

2. METHODOLOGY

2.1 Definition

A triangular fuzzy number $\tilde{A}$ is a fuzzy number fully specified by 3-tuples (a,b,c) such that $a \le b \le c$, with membership function defined as

$$\mu_{\tilde{A}}(x) = \begin{cases} 0 & if \quad x \le a \\ \dfrac{x-a}{b-a} & if \quad a \le x \le b \\ \dfrac{x-c}{c-b} & if \quad b \le x \le c \\ 0 & if \quad x \ge c \end{cases}$$

2.2 Definition

The harmonic mean *H* of the positive real numbers $x_1, x_2, \ldots. x_n$ is defined to be

$$H = \frac{n}{\dfrac{1}{x_1} + \dfrac{1}{x_2} + \ldots. + \dfrac{1}{x_n}} = \frac{n}{\sum_{i=1}^{n} \dfrac{1}{x_i}}$$

3 MATHEMATICAL CONSTRUCTION

3.1 Fuzzy Transportation Problem

Often, in Transportation Problems, the objectives are non-measurable and contradictory. Besides this, the cost coefficients in objectives are constantly indefinite due to the availability of partial information and vagueness in various potential suppliers and environments. By using simple forecasting methodology, most of these values are calculated. So solving such transportation issues with single and multi-objectives with Fuzzy is more successful than that of crisp.

Mathematically a fuzzy transportation problem can be stated as follows:

Minimize $$z = \sum_{i=1}^{m} \sum_{j=1}^{n} \tilde{c}_{ij} x_{ij}$$

Subject to the constraints

$$\sum_{j=1}^{n} x_{ij} = \tilde{a}_i \qquad j = 1, 2, \ldots, n$$

$$\sum_{i=1}^{m} x_{ij} = \tilde{b}_j \qquad i = 1, 2, \ldots, m$$

$$x_{ij} \ge 0 , \qquad i = 1, 2, \ldots, m, \quad j = 1, 2, \ldots, n$$

where *m*: Total number of sources,

n: Total number of destinations.

$\tilde{a}_i$: The fuzzy availability of the product at source.

b_j : The fuzzy demand of the product at j^{th} destination.

c_{ij} : The fuzzy transportation cost for one unit quantity of the product from i^{th} source to j^{th} destinations.

x_{ij} : Fuzzy quantity transported from i^{th} source to j^{th} destination (or fuzzy decision variables) to minimize the total fuzzy transportation.

$\sum_{i=1}^{m}\sum_{j=1}^{n}\tilde{c}_{ij} \otimes \tilde{x}_{ij}$: Total fuzzy transportation cost.

$\sum_{i=1}^{m}\tilde{a}_i$: Total fuzzy availability of the product.

$\sum_{j=1}^{n}\tilde{b}_j$: Total fuzzy demand of the product.

3.2 Method of Solution

Step 1: Check whether the problem is balanced or not. If not, make it as balanced.

Step 2: Convert fuzzy values into crisp values using Ranking function

Step 3: Interchanging the odd rows / columns and even rows / columns with the supply and demand.

Step 4: Find the Harmonic mean for each row & column.

Step 5: Discover the row/column with the maximum value and select the cell with minimum cost in the resultant row or column.

Step 6: Maximum assign is made to cell using minimum cost value. Delete the row / column where supply & demand is exhausted.

Step 7: Repeat step 3 to 5 unless the demand and supply are fulfilled.

Step 8: Calculate the total cost.

That is,

Total Cost = $\sum\sum c_{ij}x_{ij}$

3.3 Numerical Example

Consider the problem

$$[c_{ij}]_{4\times4} = \begin{pmatrix} (5,10,15) & (5,10,20) & (5,15,20) & (5,10,15) \\ (5,10,20) & (5,15,20) & (5,10,15) & (10,15,20) \\ (5,10,20) & (10,15,20) & (10,15,20) & (5,10,15) \\ (10,15,25) & (5,10,15) & (10,20,30) & (10,15,25) \end{pmatrix}$$

Solution

The given transportation problem is balanced.

(i.e.) Total supply $\sum a_i$ = Total demand $\sum b_j$

With the help of ranking function convert fuzzy values to crisp values

In Conformation to model the fuzzy transportation problem can be formulated in the following mathematical programming form

$$\begin{aligned} Min\ Z = {} & R(5,10,15)x_{11} + R(5,10,20)x_{12} + R(5,15,20)x_{13} + R(5,10,15)x_{14} \\ & + R(5,10,20)x_{21} + R(5,15,20)x_{22} + R(5,15,20)x_{23} + R(10,15,20)x_{24} \\ & + R(5,10,20)x_{31} + R(10,15,20)x_{32} + R(10,15,20)x_{33} + R(5,10,15)x_{34} \\ & + R(10,15,25)x_{41} + R(5,10,15)x_{42} + R(10,20,30)x_{43} + R(10,15,25)x_{44} \end{aligned}$$

Table after Ranking

Transportation Problem

Table 1

	D1	D2	D3	D4	Supply
O1	10	10.83	14.16	10	15
O2	10.83	14.16	10	15	10
O3	10.83	15	15	10	30
O4	15.84	10	20	15.84	20
Demand	30	15	14.16	15.84	

Interchanging the odd rows / columns and even rows / columns with the supply and demand.

Iteration – 1

Table 2

	D1	D2	D3	D4	Supply
O1	10	10.83	14.16	10	30
O2	10.83	14.16	10	15	20
O3	10.83	15	15	10	15
O4	15.84	10	20	15.84	10
Demand	14.16	15.84	30	15	

Find the Harmonic mean for each row and column.

Iteration – 2

Table 3

	D1	D2	D3	D4	Supply	*Penalty*
O1	10	10.83	14.16	10	30	*11.25*
O2	10.83	14.16	10	15	20	*12.50*
O3	10.83	15	15	10	15	*12.70*
O4	15.84	10	20	15.84	10	*15.42*
Demand	14.16	15.84	30	15		
Penalty	*11.87*	*12.45*	*14.79*	*12.71*		

With the help of our proposed algorithm, we get,

Fuzzy Optimal Solution

Table 4

	D_1	D_2	D_3	D_4	Supply
O_1	**15** 10	10.83	14.16	10	15
O_2	**0.84** 10.83	14.16	**9.16** 10	15	10
O_3	**14.17** 10.83	15	15	**15.83** 10	30
O_4	15.83	**15** 10	**5** 20	15.83	20
Demand	30	15	14.16	15.83	

Hence (4+4-1)=7 cells are allocated and hence we got our feasible soln. Next we calculate total cost and its corresponding allocated value of supply demand which is shown in Table

Total Cost = (10X15)+(10.83X0.84)+(10X9.16)+(10.83X14.17)+

(10X15.83)+ (15X10)+(20X5) = Rs. 812.4283

4. CONCLUSIONS

Transportation models have wide applications in logistics and supply and demand chain for reducing the cost. In this paper, we have obtained an optimal solution for a fuzzy transportation problem using a triangular fuzzy number. The arithmetic operations of triangular fuzzy numbers are employed to get the optimal solution.

REFERENCES

1. *Bellman R, Zadeh L.A. (1970), 'Decision making in a fuzzy environment', Management science, vol. 17, pp. 141 – 164*
2. *Chanas, S, Kuchta D, (1996), 'A concept of the optimal solution of the transportation problem with fuzzy cost coefficients' Fuzzy sets and systems, vol. 82, pp. 299-305*
3. *Chanas, S, Kuchta, D, (1998), 'Fuzzy integer transporting problem', Fuzzy sets and systems, vol. 98, pp. 291-298.*
4. *Zimmermann, H, J. (1978), Fuzzy programming and linear programming with several objectives, Fuzzy sets and systems, vol. 1, pp. 45-55.*
5. *Roseline, S. S., & Amirtharaj, E. H. (2013). A new ranking of intuitionistic fuzzy numbers with distance method based on the circumcenter of centroids. International Journal of Applied Mathematics & Statistical Sciences (IJAMSS), 2(4), 37-44.*